



(12) **United States Patent**
Mathew et al.

(10) **Patent No.:** **US 9,515,131 B2**
(45) **Date of Patent:** ***Dec. 6, 2016**

(54) **NARROW BORDER ORGANIC
LIGHT-EMITTING DIODE DISPLAY**

(71) Applicant: **Apple Inc.**, Cupertino, CA (US)

(72) Inventors: **Dinesh C. Mathew**, Fremont, CA (US);
Adam T. Garelli, Santa Clara, CA
(US); **Paul S. Drzaic**, Morgan Hill, CA
(US); **Wei Chen**, Palo Alto, CA (US);
Brett W. Degner, Menlo Park, CA
(US); **Bryan W. Posner**, La Selva
Beach, CA (US)

(73) Assignee: **Apple Inc.**, Cupertino, CA (US)

(*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
U.S.C. 154(b) by 0 days.

This patent is subject to a terminal dis-
claimer.

(21) Appl. No.: **14/948,157**

(22) Filed: **Nov. 20, 2015**

(65) **Prior Publication Data**

US 2016/0079337 A1 Mar. 17, 2016

Related U.S. Application Data

(63) Continuation of application No. 13/588,831, filed on
Aug. 17, 2012, now Pat. No. 9,214,507.

(51) **Int. Cl.**

H01J 1/62 (2006.01)

H01L 27/32 (2006.01)

(Continued)

(52) **U.S. Cl.**

CPC **H01L 27/3276** (2013.01); **G06F 3/041**
(2013.01); **H01L 51/0097** (2013.01);

(Continued)

(58) **Field of Classification Search**

CPC . G06F 3/0412; H01L 27/3276; H01L 51/5293

(Continued)

(56) **References Cited**

U.S. PATENT DOCUMENTS

2,933,655 A 4/1960 Gradisar et al.

4,066,855 A 1/1978 Zenk

(Continued)

FOREIGN PATENT DOCUMENTS

CN 101106157 1/2008

CN 101430473 5/2009

(Continued)

OTHER PUBLICATIONS

US 9,224,326, 12/2015, Wright et al. (withdrawn)

Primary Examiner — Vip Patel

(74) *Attorney, Agent, or Firm* — Treyz Law Group, P.C.;
G. Victor Treyz; Zachary D. Hadd

(57) **ABSTRACT**

An electronic device may be provided having an organic light-emitting diode display and control circuitry for operating the display. The display may include one or more display layers interposed between the control circuitry and a display layer having thin-film transistors. The electronic device may include a coupling structure interposed between the layer of thin-film transistors and the control circuitry that electrically couples the layer of thin-film transistors to the control circuitry. The coupling structure may include a dielectric member having a conductive via, a flexible printed circuit having a bent portion, or a conductive via formed in an encapsulation layer of the display. The display may include a layer of opaque masking material. The layer of opaque masking material may be formed on an encapsulation layer, an organic emissive layer, a thin-film transistor layer, or a glass layer of the organic light-emitting diode display.

20 Claims, 9 Drawing Sheets

